

Mark scheme

1 Principles of chemistry 1

Practical work

Question	Answers and guidance	Marks
1 a)	Melting	1
	In the ice the particles are in a regular arrangement; in water they have no fixed pattern	1
	In the ice the particles cannot move around/they can only vibrate; but in the liquid they can move around each other	1
b)	In the water the particles have more energy as the temperature increases	1
	so the particles move quicker as the temperature rises	1
	When the water boils the particles separate from each other	1
	and leave the beaker, reducing the water level.	1
c)	Condensation	1
	The widely separated particles lose energy	1
	The particles get closer together to form a liquid on the cold surface	1
Total		10

Question	Answers and guidance	Marks
2 a)	The particles have no fixed pattern or arrangement	1
	They are moving quickly	1
	They are widely separated	1
b)	The particles have no fixed pattern or arrangement	1
	The particles are touching each other	1
	The particles are free to move	1
	The particles have less energy than at point A (in a gas)	1
c)	The particles cannot move; they can only vibrate	1
	The particles are in a fixed arrangement	1
	The particles have little energy	1
Total		10

Question	Answers and guidance	Marks
3 a)	The particles have a fixed pattern or arrangement	1
	The particles are not free to move	1
b) i)	The liquid is now purple	1
	The colour is evenly spread throughout the test tube	1
ii)	The crystal particles have separated from each other	1
	and spread evenly	1
	in between the water particles	1
iii)	Diffusion	1
c) i)	The original crystal must contain enough particles to colour the 10 cm ³ of water/the repeated dilutions show that there are very many particles in each 1 cm ³ of solution	1
	To keep the colour after four dilutions means that the crystal must contain a very large number of particles	1
	As the crystal was very small, and produces a lot of particles, the particles must be very small	1
ii)	There are not sufficient particles to colour the water	1
	but particles of potassium manganate(VII) are still present	1
Total		13

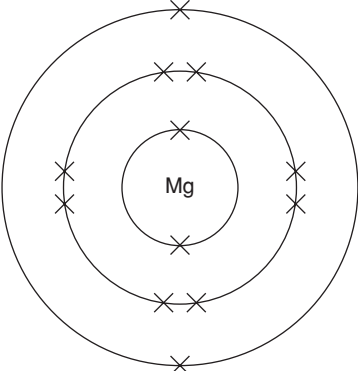
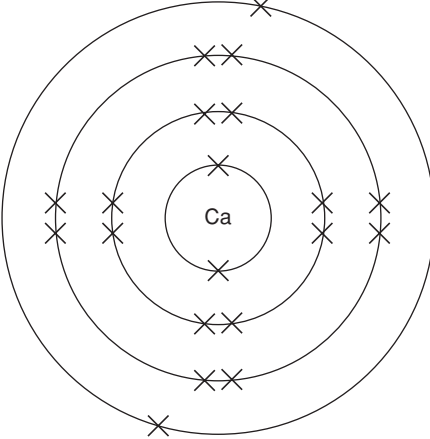
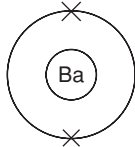
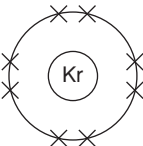
Using the Periodic Table

Question	Answers and guidance	Marks
1 a) i)	Atomic number is 6 Mass number is 12	1 1
ii)	2, 4	1
iii)	Carbon	1
b) i)	Group 4	1
ii)	Any named from: silicon, germanium, tin or lead	1
iii)	Any named from: lithium, beryllium, boron, nitrogen, oxygen, fluorine, or neon	1
iv)	Elements in the same group have the same number of outer electrons so any element in Group 4 will have the same number of outer electrons	1 1
Total		9

Question	Answers and guidance	Marks
2 a) i)	19	1
ii)	The number of neutrons is 20	1
iii)	Mass number is 39 Add together the protons and the neutrons	1 1
b) i)	2, 8, 8, 1	1
ii)	Group 1	1
c) i)	Rubidium, caesium or francium	1
ii)	One Elements in the same group of the Periodic Table have the same number of outer electrons	1 1
Total		9

Question	Answers and guidance	Marks																																								
3 a)	1 mark for each correct row	4																																								
	<table><tr><th rowspan="2">Name</th><th rowspan="2">Mass number</th><th colspan="4">Number of</th></tr><tr><th>Protons</th><th>Neutrons</th><th>Electrons</th><th>Outer electrons</th></tr><tr><td>fluorine</td><td>19</td><td>9</td><td>10</td><td>9</td><td>7</td></tr><tr><td>chlorine</td><td>35</td><td>17</td><td>18</td><td>17</td><td>7</td></tr><tr><td>bromine</td><td>80</td><td>35</td><td>45</td><td>35</td><td>7</td></tr><tr><td>iodine</td><td>127</td><td>53</td><td>75</td><td>53</td><td>7</td></tr><tr><td>chlorine</td><td>37</td><td>17</td><td>20</td><td>17</td><td>7</td></tr></table>		Name	Mass number	Number of				Protons	Neutrons	Electrons	Outer electrons	fluorine	19	9	10	9	7	chlorine	35	17	18	17	7	bromine	80	35	45	35	7	iodine	127	53	75	53	7	chlorine	37	17	20	17	7
	Name				Mass number	Number of																																				
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	iodine		127	53	75	53	7																																			
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b) i)	2, 7	1																																								
ii)	7	1																																								
iii)	Elements in the same group of the Periodic Table have the same number of outer electrons	1																																								
c) i)	For 1 mark: they have different numbers of neutrons For 2 marks: chlorine-35 has 18 neutrons and chlorine-37 has 20 neutrons	2																																								
ii)	Isotopes	1																																								
d)	$\frac{(35 - 3) + (37 - 1)}{4}$ or $\frac{(35 + 35 + 35 + 37)}{4}$ = 35.5	1 1																																								
Total		12																																								

Question	Answers and guidance	Marks
4 a)	S and R	1
b)	W and Q or S and T	1
c)	S and R	1
d)	S and R Elements in the same group always have the same number of outer electrons	1 1
e)	S = 2, 2 P = 2, 8, 4 T = 2, 8	1 1 1
f)	Iron	1
g)	Au	1
Total		10

Question	Answers and guidance	Marks
5 a) i)		1
ii)		1
b)	They both have two outer electrons Elements with the same number of outer electrons are in the same group.	1 1
c)	Magnesium has (two) outer electrons it can lose Argon has no outer electrons/has a full outer electron shell	1 1
d) i)		1
ii)		1
Total		8

Calculations

Question	Answers and guidance	Marks
1 a)	$(1 \times 2) + 32 + (16 \times 4)$ $= 98$	1 1
b)	$24 + 32 + (16 \times 4)$ $= 120$	1 1
c)	$\frac{\text{mass used}}{\text{Mg relative atomic mass}}$ OR $\frac{24}{24}$ $= 0.1 \text{ mol}$	1 1
d)	1 mol of Mg makes 1 mol of hydrogen, so 0.1 mol	1
e)	$0.1 \text{ mol} \times 24 \text{ dm}^3$ $= 2.4 \text{ dm}^3$	1 1
Total		9

Question	Answers and guidance	Marks
2 a)	$40 + 16$ $= 56$	1 1
b)	$40 + 12 + (16 \times 3)$ $= 100$	1 1
c)	100 tonnes of CaCO_3 makes 56 tonnes of CaO so $100 - 56$ $= 44$ tonnes of CO_2 OR 1 mole of CaCO_3 makes 1 mole of CaO and 1 mole of CO_2 so 100 tonnes will make 44 tonnes	1 1 1 2 1
d) i)	$(1 \times 2) + 12 + (16 \times 3)$ $= 62$	1 1
ii)	$\frac{0.88}{(12 + 16 + 16)}$ $= 0.02 \text{ mol}$	1 1
iii)	$0.02 \times 24 \text{ dm}^3$ $= 0.48 \text{ dm}^3$	1 1
iv)	$\frac{\text{number of moles}}{\text{volume of solution in dm}^3}$ so $0.02 \times \frac{1}{0.2} \text{ dm}^3$ $= 0.01 \text{ mol/dm}^3$	1 1
Total		15

Question	Answers and guidance	Marks
3 a) i)	$14 + (1 \times 3)$ $= 17$	1 1
ii)	$14 + (1 \times 4) + 16 + 1$ $= 35$	1 1
b) i)	moles dissolved $= \frac{12}{24}$ $= 0.5$	1 1
ii)	mass dissolved $= 0.5 \times 17$ $= 8.5 \text{ g}$	1 1
iii)	0.5 mol/dm^3	1
c)	$\frac{0.5}{2}$ $= 0.25 \text{ mol/dm}^3$	1 1
d) i)	$14 + (1 \times 4) + 35.5$ $= 53.5$	1 1
ii)	$\frac{13.4}{53.5}$ $= 0.25$	1 1
Total		15

Question	Answers and guidance	Marks
4 a) i)	$(1 \times 2) + 16$ $= 18$	1
ii)	$40 + [(16 + 1) \times 2]$ $= 74$	1
iii)	$40 + 12 + (16 \times 3)$ $= 100$	1
b) i)	$\frac{\text{amount used}}{\text{relative formula mass of Ca(OH)}_2} = \frac{1.48}{74}$ $= 0.02 \text{ mol}$	1 1
ii)	0.02×100 $= 2.0 \text{ g}$	1 1
iii)	$0.02 \times 24 \text{ dm}^3$ $= 0.48 \text{ dm}^3$	1 1
Total		9

Question	Answers and guidance	Marks
5 a)	$1 + 35.5$ $= 36.5$	1 1
b)	$24 + (35.5 \times 2)$ $= 95$	1 1
c)	24 g	1
d)	mol of magnesium $= \frac{6}{24} = 0.25$ 0.25 mol of hydrogen gas is made, so $0.25 \times 24 \text{ dm}^3 = 6 \text{ dm}^3$	1 1
Total		7

1 Principles of chemistry 2

Charges, chemical formulae and equations

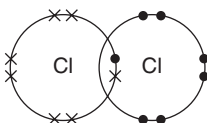
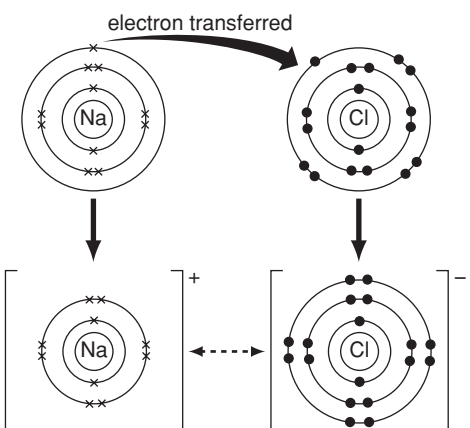
Question	Answers and guidance	Marks
1 a)	mass of crucible, lid and magnesium — mass of crucible and lid OR $18.24 - 16.81$ $= 1.43 \text{ g}$	1
b)	$\frac{1.43}{24}$ $= 0.059 \text{ mol}$	1 1
c)	mass of crucible, lid and magnesium oxide — mass of crucible, lid and magnesium OR $19.16 - 18.24$ $= 0.92 \text{ g}$	1
d)	$\frac{0.92}{16}$ $= 0.058 \text{ mol}$	1 1
e)	Reacting ratio is 1 : 1, so empirical formula will be MgO	1 1
Total		8

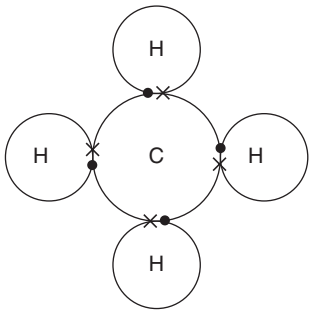
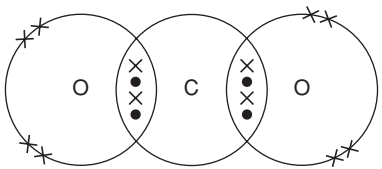
Question	Answers and guidance	Marks
2 a) i)	Iron is Fe^{3+} Oxygen is O^{2-} Formula is Fe_2O_3	1
ii)	$4\text{Fe(s)} + 3\text{O}_2\text{(g)} \rightarrow 2\text{Fe}_2\text{O}_3\text{(s)}$ 1 mark for reactants; 1 mark for products	2
iii)	Gains (two) electrons	1
b) i)	$14.34 - 12.42 = 1.92 \text{ g}$	1
ii)	$\frac{1.92}{16}$ $= 0.12 \text{ mol}$	1 1
iii)	$\frac{12.42}{207}$ $= 0.06 \text{ mol}$	1 1
iv)	The ratio of lead to oxygen is 0.06 : 0.12 or 1 : 2 The empirical formula will be PbO_2	1 1
Total		11

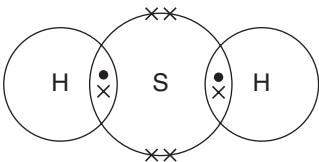
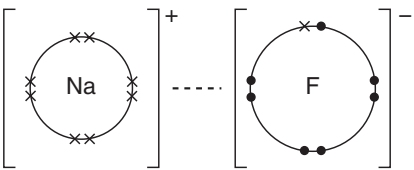
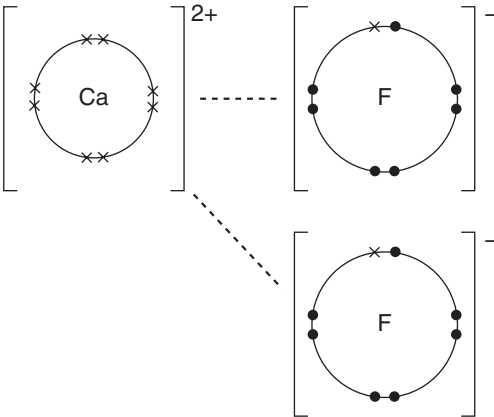
Question	Answers and guidance	Marks
3 a) i)	$\frac{5.9}{24}$	1
	= 0.00245 mol	1
ii)	$\frac{11.9}{24}$	1
	= 0.00496 mol	1
iii)	0.00245 : 0.00496 or 1 : 2	1
iv)	H ₂ O	1
b) i)	$\frac{14.3}{1}$	1
	= 14.3 mol	1
ii)	100 – 14.3 = 85.7	1
	$\frac{85.7}{12}$	1
	= 7.14 mol	1
iii)	The ratio of hydrogen to carbon is 14.3 : 7.14 or 2 : 1	1
	The empirical formula will be CH ₂	1
iv)	Molecular mass of CH ₂ is 14, so if the molecular mass is 28	1
	there will be $\frac{28}{14}$	1
	or 2 CH ₂ units, or a molecular formula of C ₂ H ₄	1
Total		15

Question	Answers and guidance	Marks
4 a) i)	31.9 – (12.7 + 6.4)	1
	= 12.8 g	1
ii)	$\frac{12.8}{16}$	1
	= 0.8 mol	1
iii)	For Cu: $\frac{12.7}{63.5} = 0.2$ mol	1
	For S: $\frac{6.4}{32} = 0.2$ mol	1
	Ratio Cu : S : O = 0.2 : 0.2 : 0.8 or 1 : 1 : 4	1
	So formula is CuSO ₄	
b)	Moles of MnSO ₄ = $\frac{15.1}{55 + 32 + (16 \times 4)} = 0.1$ mol	1
	Mass of water = 22.3 – 15.1 = 7.2 g	1
	Moles of H ₂ O = $\frac{7.2}{16 + (1 \times 2)} = 0.4$ mol	1
	Ratio is 0.1 : 0.4 or 1 : 4, so x = 4	1
Total		11

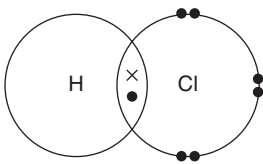
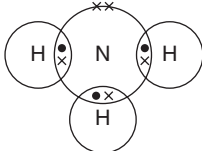
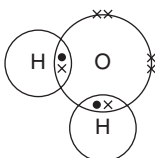
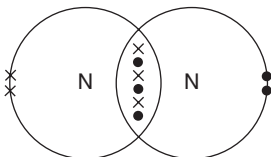
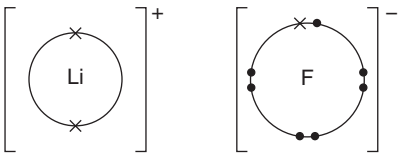
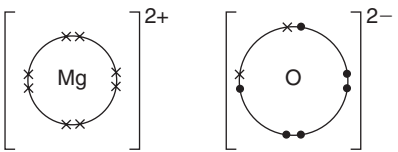
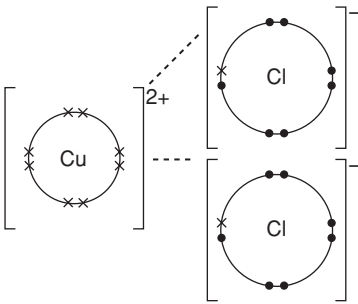
Using electronic configurations

Question	Answers and guidance	Marks
1 a) i)	2 electrons on inner shell and 8 electrons on middle shell 7 electrons on outer shell	1 1
ii)	1 mark for overlapping outer orbits 1 mark for bonding pair of electrons (there is no need to show inner complete shells) 	1 1
b) i)	8 electrons on middle shell 1 electron on outer shell	1 1
ii)	1 mark for Na atom becoming Na^+ ion showing loss of electron to Cl 1 mark for Cl atom becoming Cl^- ion showing gain of electron from Na 	1 1
Total		8

Question	Answers and guidance	Marks
2 a)	2 electrons on inner shell 4 electrons on outer shell	1 1
b)		1
c) i)	2 electrons on inner shell 6 electrons on outer shell	1 1
ii)	 1 mark for two bonding pairs to one oxygen 1 mark for two bonding pairs to second oxygen atom	2
Total		7

Question	Answers and guidance	Marks
3 a) i)	2, 8, 1	1
ii)	2, 8, 8, 2	1
iii)	2, 7	1
iv)	2, 8, 6	1
v)	1	1
b) i)	 <p>1 mark for showing shared pair of electrons 1 mark for 2 atoms of hydrogen</p>	2
ii)	 <p>1 mark for showing sodium ion 1 mark for showing fluoride ion</p>	2
iii)	 <p>1 mark for showing calcium ion 1 mark for showing two fluoride ions</p>	2
Total		11

Question	Answers and guidance					Marks
4	1 mark for each correct complete row					
	Element	Proton number	Electronic configuration of an atom	Electronic configuration of an ion	Number of outer electrons of an atom	
	neon	10	2, 8	no ion	8	1
	beryllium	4	2, 2	2	2	1
	nitrogen	7	2, 5	2, 8	5	1
	aluminium	13	2, 8, 3	2, 8	3	1
	phosphorus	15	2, 8, 5	2, 8, 8	5	1
Total						5

Question	Answers and guidance	Marks
5 a) i)		1
ii)	 <p>1 mark for three bonding pairs 1 mark for one lone pair</p>	1
iii)	 <p>1 mark for two bonding pairs 1 mark for two lone pairs</p>	1
iv)		1
b) i)	 <p>1 mark for lithium ion 1 mark for fluoride ion</p>	1
ii)	 <p>1 mark for magnesium ion 1 mark for oxide ion</p>	1
iii)	 <p>1 mark for copper ion 1 mark for chloride ions</p>	1
Total		12

Data analysis

Question	Answers and guidance	Marks
1 a)	P	1
b)	S	1
c)	S It conducts electricity both as a solid and a liquid	1 1
d)	R Does not conduct electricity and has very high melting and boiling points	1 1
Total		6

Question	Answers and guidance	Marks
2 a)	Sodium chloride Any two for 1 mark each from: <ul style="list-style-type: none"> • high melting and boiling points • good conductor of electricity when dissolved and molten. • reference to crystal lattice structure 	1 2
b)	EITHER Chlorine is made of molecules/has covalent molecules which have strong attractions within the molecule but not to other substances OR Sodium chloride is made of charged ions that are easily attracted to/interact easily with other substances	1 1 1 1
c)	In NaCl: <ul style="list-style-type: none"> • there are strong attractions/electrostatic forces between the different charged ions • each sodium ion is attracted to six other chloride ions In chlorine: <ul style="list-style-type: none"> • the chlorine molecules have very weak attractions between the molecules • so they need less energy to separate them 	1 1 1 1
Total		9

Question	Answers and guidance	Marks
3 a)	NCl_3	1
b)	Covalent It has a low boiling point	1 1
c)	As atomic number increases the boiling points decrease Except for element 5 which is too low	1 1
d)	3 and 4	1
e)	It is a noble gas/has full outer orbit of electrons so there are no electrons to lose, gain or share	1 1
f)	2+ With formula LiCl the Cl is giving one minus charge, so it needs one positive charge to balance	1 1
Total		10

Question	Answers and guidance	Marks
4 a)	Each carbon atom in diamond is bonded to four others	1
	Each carbon atom in graphite is bonded to three others	1
	This means that a lot of energy is needed to separate the atoms so the melting points are very high	1
b)	The four bonds makes the diamond structure very hard	1
	so it will cut softer materials	1
c)	The graphite is in layers	1
	that can easily slip past each other	1
	The layers are very strong so they do not melt at high temperatures	1
d)	Each carbon atom in graphite has a single unbonded electron	1
	This electron is delocalised/can move in the graphite	1
	so it can produce a flow of electricity/electrons through graphite	1
	All the carbon atom's electrons are bonded/no electrons are free to move in diamond	1
Total		12